

REMARKS

Reconsideration of this application, as amended, is respectfully requested.

Claims 12-22 are pending. Claims 12-13 and 17-19 stand rejected. Claims 14 and 21 have been objected to.

Claims 12, 14, 18, 19, and 21 have been amended. No claims have been cancelled. No claims have been added. Support for the amendments is found in the specification, the drawings, and in the claims as originally filed. Applicants submit that the amendments do not add new matter.

Restriction Requirements

The Office Action has required restriction to one of the inventions in this application under 35 USC §121. The Applicants affirm election to prosecute claims 12-14, 17-19 and 21 without traverse.

Information Disclosure Statement

The information disclosure statement filed on February 10, 2004 fails to comply with 37 C.F.R. 1.98(a)(1).

In response, Applicants amended the Information Disclosure Statement to comply with 37 C.F.R. 1.98(a)(1).

Drawings

The drawings are objected to under 37 C.F.R. 1.83(a). The Examiner stated that

The drawings must show every feature of the invention specified in the claims. Therefore, the metallization over which the copper pad and the Ti metal adhesion first layer must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

(p. 3, Office Action 022305)

Applicants have amended claim 18 to replace the feature of “forming a copper pad over a metal six metallization” by the feature of “ forming a copper pad over a substrate” to overcome the Examiner’s objection of the drawings.

Claims Objections

Claims 18 and 19 are objected to because of informality.

Applicants have amended claims 18 and 19 in light of the Examiner’s suggestions, to overcome the objection.

Applicants have amended claim 18 in light of the Examiner’s comments to cancel the metallization feature from the claim.

Rejections Under 35 U.S.C. § 102(e)

Claims 12 and 17 stand rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent Application No. 2002/0086520 of Chiang (“Chiang”).

Applicants have amended claim 12 to indicate that a second metal layer comprises copper and the metal third layer is selected from a group consisting of a refractory metal, a metal-doped refractory metal, and a refractory metal alloy.

Amended claim 12 reads as follows.

A process comprising:
forming a metallization over a substrate;
forming a metal adhesion first layer above and on the metallization;
forming a metal second layer above and on the metal adhesion first layer
forming a metal third layer above and on the metal second layer;
forming a solder bump above and on the metal third layer, and
wherein the metal second layer comprises a copper and the metal third layer
is selected from a group consisting of a refractory metal, a metal-doped refractory
metal, and a refractory metal alloy.

(Amended claim 12) (emphasis added)

Chiang, in contrast to the presently claimed subject matter, discloses forming a nickel-vanadium layer on a titanium layer, and then forming a copper layer on the nickel-vanadium layer. More specifically, Chiang discloses

Referring to FIG. 3, the under bump metallurgy 340 of the present invention comprises a titanium layer 340a formed on the exposed portion of the copper contact pad 330, a nickel-vanadium layer 340b formed on the titanium layer 340a and a copper layer 340c formed on the nickel-vanadium layer 340b.

(Chiang, Paragraphs 0020-0021)

Thus, Chiang, in contrast, discloses forming a copper layer on a nickel-vanadium layer, and not forming a refractory metal, a metal-doped refractory metal, and a refractory metal alloy above and on the copper layer, as recited in amended claim 12.

Because Chiang does not set forth all the limitations of amended claim 12, Applicants respectfully submit that amended claim 12 is not anticipated by Chiang under 35 U.S.C. § 102(e).

Given that claim 13 and 17 depend directly from amended claim 12, and add additional limitations, Applicants respectfully submit that claims 13 and 17 are likewise not anticipated by Chiang under 35 U.S.C. § 102(e).

Rejections Under 35 U.S.C. § 103(a)

Claim 13 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Application No. 2002/0086520 of Chiang (“Chiang”) in view of U.S. Patent No. 4,514,751 of Bhattacharya (“Bhattacharya”).

As set forth above, Chiang fails to disclose, teach, or suggest the limitation of amended claim 12 of forming a metal third layer above and on the metal second layer, wherein the metal

second layer comprises copper and the metal third layer is selected from a group consisting of a refractory metal, a metal-doped refractory metal, and a refractory metal alloy, as recited in amended claim 12.

Bhattacharya discloses a compressively stressed titanium underlayer covered by a solder bondable layer, wherein the solder bondable layer is a composite of layers of copper, titanium, copper, and gold. More specifically, Bhattacharya discloses

FIG. 3 discloses a metallurgical combination of compressive titanium 10, copper 11, titanium 12, copper 13 and gold 14 which solves the high current density problem of FIG. 2 without reintroducing the quartz cracking problem associated with merely increasing the thickness of the layer 6 of FIG. 2.

(Bhattacharya, col.3, lines 42-47) (emphasis added)

Thus, in contrast to the presently claimed subject matter, Bhattacharya merely discloses forming layers of copper, titanium, copper, and gold on a titanium layer, and not forming a refractory metal, a metal-doped refractory metal, and a refractory metal alloy above and on the copper layer, as recited in amended claim 12. Accordingly, Bhattacharya, similarly to Chiang, fails to disclose, teach, or suggest such limitation of amended claim 12.

Hence, neither Chiang, nor Bhattacharya discloses, teaches, or suggests such limitation of amended claim 12.

Consequently, even if Chiang and Bhattacharya were combined, such a combination would lack the limitation of amended claim 12 of forming a metal third layer above and on the metal second layer, wherein the metal second layer comprises copper and the metal third layer is selected from a group consisting of a refractory metal, a metal-doped refractory metal, and a refractory metal alloy.

Therefore, Applicants respectfully submit that amended claim 12 is not obvious under 35 U.S.C. § 103 (a) over Chiang in view of Bhattacharya.

Given that claim 13 depends from amended claim 12 and adds additional limitations, Applicants respectfully submit that claim 12 is likewise not obvious under § 103 (a) over Chiang in view of Bhattacharya.

Claims 18-19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Application No. 2002/0086520 of Chiang (“Chiang”) in view of U.S. Patent No. 6,667,230 of Chen et al. (“Chen”).

Applicants have amended claim 18 to indicate that the metal second layer comprises copper and the metal third layer comprises a refractory metal.

Amended claim 18 reads as follows.

A process comprising:
forming a copper pad over a substrate;
sputtering a Ti metal adhesion first layer above and on the copper pad;
sputtering a metal second layer above and on the Ti metal adhesion first layer;
forming a metal third layer above and on the metal second layer;
forming a solder bump above and on the metal third layer, and
wherein the metal second layer comprises copper and the metal third layer
comprises a refractory metal, a metal-doped refractory metal, and a refractory metal
alloy.

(Amended claim 18) (emphasis added)

As set forth above, Chiang fails to disclose, teach, or suggest the limitation of amended claim 18 of forming a metal third layer above and on the metal second layer, wherein the metal second layer comprises copper and the metal third layer is selected from a group consisting of a refractory metal, a metal-doped refractory metal, and a refractory metal alloy.

Chen discloses a completely different structure than claimed by Applicants. More specifically, Chen discloses the metal interconnect layers and metal plugs formed on the metal interconnect layers and, similarly to Chiang, fails to disclose, teach, or suggest forming a metal third layer above and on the metal second layer, wherein the metal second layer comprises

copper and the metal third layer is selected from a group consisting of a refractory metal, a metal-doped refractory metal, and a refractory metal alloy, as recited in amended claim 18.

Hence, neither Chiang, nor Chen discloses, teaches, or suggests such limitation of amended claim 18.

Consequently, even if Chiang and Chen were combined, such a combination would lack such limitation of amended claim 18.

Therefore, Applicants respectfully submit that amended claim 18 is not obvious under 35 U.S.C. § 103 (a) over Chiang in view of Chen.

Given that claim 19 depends from amended claim 18 and adds additional limitations, Applicants respectfully submit that claim 19 is likewise not obvious under § 103 (a) over Chiang in view of Chen.

Allowable Subject Matter

Applicants note with appreciation the Examiner's allowance of the claims 14 and 21, if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

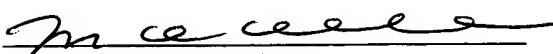
Applicants here have amended the claims 14 and 21 in light of this suggestion.

Thus, claims 14 and 21 now are rewritten in independent form and include all the limitations of respective independent claims 1 and 18, and are now allowable.

It is respectfully submitted that in view of the amendments and arguments set forth herein, the applicable rejections and objections have been overcome. If there are any additional charges, please charge Deposit Account No. 02-2666 for any fee deficiency that may be due.

Respectfully submitted,

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